Responses to questions on the report, "Soil Health of Mountaintop Removal Mines in Southern West Virginia."

General Comments

1. Why were no native soils collected from gently sloping sites, such as cove areas or at the base of the mountains?

Our approach was to sample the predominant landscapes of both the minesoils and the native soils. The predominant landscape of the native soils had steep to very steep slopes, whereas, the minesoils were nearly level to gently sloping at the Hobet and Cannelton sites. Also, we wanted to sample native soils as close as possible to the minesoil areas so that geology of both minesoils and native soils would be similar, and to sample native soils that were similar to the native soils covering the mined areas before mining.

2. Since A horizons are naturally thin in forest soils and thick in grassland soils, and there are probably other differences between forested and grassland soils, isn't comparing these two data sets somewhat of an "apples and oranges" exercise? Would it be more appropriate to evaluate data for the reclaimed mine soils to peer-reviewed literature values for grassland soils in the eastern U.S.? There should be more of an effort in the report to compare the results to those of other peer-reviewed studies to provide some context for the mine soil results.

In this study, we were simply comparing two contiguous soils in the area: minesoils and native soils. If we start comparing our soils to well-developed grassland soils, we definitely will have an "apples and oranges" exercise. Geology, climate and elevation would differ for our study and grassland soils in the literature. When the morphology of the total profile is considered, our minesoils are very similar to the contiguous native soils. Most of the native soils had Bw horizons (classified as cambic), and thin, light-colored A horizons (classified as ochric). Therefore, they would fit the Inceptisols order in Soil Taxonomy. Most of the minesoils had AC or Bw horizons. If the Bw was present, it was either classified as cambic or approaching cambic. AC horizons are transitional horizons that are also approaching cambic. In other words, given a few more years of weathering and soil development, these minesoils will have cambic horizons. All minesoils had ochric epipedons (surface horizons) just like the native soils. Most grassland soils in midwestern and eastern U.S. are classified as Alfisols or Mollisols. Our minesoils will most likely become Inceptisols (the classification of the native soils) as they mature**.** Data from numerous studies support this conclusion. After the minesoils become Inceptisols, they may become Alfisols, Ultisols, or Mollisols at some later date. Data would indicate that many of the minesoils that are now classified as Entisols will become Inceptisols within a few to 10s of years. Most of the native soils in this area are classified as Inceptisols. The minesoils will not become Alfisols, Ultisols, or Mollisols for probably hundreds to thousands of years. Therefore, the minesoils are similar to the surrounding native soils.

Since funding and time were limited for this study, we did not include detailed comparisons with depth for the the major morphological, chemical or physical properties of the minesoils or native soils. The morphological properties were given primarily for background soil property information. The main emphasis of the study was microbial biomass which we evaluated by determining microbial biomass C and N, potentially mineralizable N, and microbial respiration of surface horizons. We used literature references to compare our biomass data to other studies. On page 5 of the report we comare our data to data from Anderson and Domsch (1989), Bonde et al. (1988), Insam and Domsch (1988), Jenkinson (1988), Li (1991), Myrold (1987), Prince and Raney (1961), Rice et al. (1996), and Sparling (1992). We showed where our data were similar to and where they differed from these studies.

3. It would be helpful if the report would elaborate more on why these particular parameters (microbial biomass, etc.) were chosen for study (e.g., their significance in understanding soil development), as well as what parameters were not studied due to time/funding constraints and how the omitted parameters might also be important to evlauating soil development.

Various references recommend a data set of soil physical, chemical, and biological indicators for screening the condition, quality and health of soil (See Doran et al., 1999). These indicators are grouped into three categories: physical, chemical and biological. The major indicators listed under the biological category are microbial biomass C and N, potentially mineralizable N, and soil respiration, which are the same properties that we measured. Many minesoil studies have concentrated on the chemical and physical properties, but we could find only very limited data on minesoil microbial biomass data. Since our funding and time for this study were limited, we chose to concentrate on the microbial properties. This was discussed at one of the early meetings of the research group, and my understanding from that meeting was that although other data were desirable, it was clear to everyone that limitations of funding and time would preclude additional information. In order to assist with the time constraints, we used sites at Dal-Tex that were already selected for another study. Therefore, we used the same soil pits exposed for that study, and we used laboratory chemical and physical data collected for that study. I felt that the Dal-Tex data were important for our study although we did not have enough funds to select new sample sites and collect new chemical, physical and morphological data. We simply sampled existing soil pits for the microbial analyses. Plus we used additional areas at two other sites where terrestrial habitat studies were taking place, and located our sampling stations near Dr. Wood's transects.

Also, the study would have been more solid if we could have compared the key properties with depth in the minesoil profiles. Again, the limitations of funding and time placed upon us precluded those comparisons.

Specific Comments

1. The reviewer stated that page 2, first paragraph needed clarification; specifically the following sentences: "However, minesoils are subject to the same soil forming factors and processes that have developed the contiguous native soils. These processes will eventually develop minesoils with properties similar to the native soils."

These were general, introductory statements. The five soil forming factors are climate, organisms, relief or topography, parent material, and time. Some of the major internal soil forming processes are leaching from the soil profile, accumulation of organic matter, movement of materials from one horizon or depth to some lower depth, production and accumulation of clay. We were simply saying that these soil forming factors work within minesoils just as they work within native soils. If the factors of soil formation are similar, then the internal processes will also be similar. Therefore, minesoils should eventually (over some period of time) have properties that are very similar to the contiguous native soils because climate and parent material are the same and organisms and topography will be more similar.

2. The reviewer asked us to elaborate on which properties were documented, why they're important, and what they tell us about the soil development and soil "health."

Microbial biomass C and N, potentially mineralizable N, and soil respiration were documented for minesoils of different ages. These are considered by numerous authors (see Doran et al., 1999) as key biological properties that indicate the health of the soil. Healthy soils have stable levels of each of these properties.

Methods and Materials: Side Descriptions and Field Sampling

1. Explain how each sampling location was chosen out of all those acres of possiblilites.

As explained above, we used sampling sites on the Dal-Tex sites that had been selected for another study and had some physical, chemical, and morphological data available. This site consisted of four different aged minesoils. The sampling points were selected to represent the general vegetation and landscape position of the site. Both southern-facing, steep slopes and nearly level to gently sloping sites were selected. Native soils were sampled on southern-facing steep slopes contiguous to the minesoils.

At the Hobet and Cannelton sites we started the site selection process by contacting personnel working on Dr. Wood's wildlife study. We were shown the

locations of the wildlife sampling areas in the field. We wanted to sample in the same general vicinity of the wildlife plots, so we chose to sample our soils 50 m outside the wildlife plot boundary. These initial points were selected to represent the general vegetation on the site. Two additional soil sampling points were selected on a straight-line transect so that the distance between each sampling point was 250 m. Each of the three sampling points represented similar landscape positions, slope, and vegetation. If these sampling points did not represent the dominant vegetation of the area, we moved a few meters to locate in the more representative vegetative cover. By sampling in this manner, all of our soil pits should have been close to wildlife plots.

2. Some sample locations were placed on steeply sloping, some on gently sloping sites. Is that because an intent of the sampling was to evaluate the effect of slope on soil development?

It was not the intent of this study to compare steeply sloping and gently sloping minesoils. Therefore, the dominant landscape positions at Hobet and Cannelton, i.e. gently sloping, were sampled. Likewise, the dominant landscape (steeply sloping) of the native soils was sampled. As explained above, both steeply sloping and gently sloping sites were used at Dal-Tex simply because they were available from another study.

3. A table showing the characteristics of each sampling location (vegetation, slope, aspect, age, reclamation methods used, etc.) would be very helpful.

Slope and age of all the sampling sites are provided in Appendix Table 2. Aspect of all sites is given in the text of the report on page 2. General vegetation at each site is described on page 3 of the report. I do not understand why these data would need to be repeated in another table. We do not know the reclamation methods.

4. The vegetation at the 30-year-old site at Cannelton is atypical when compared to most reclaimed mountaintop removal mines. If data from this site are to be used, the vegetation differences should be more clearly described, and an attempt made to understand what reclamation practice resulted in this soil/vegetation association.

It is evident from the data presented that the total C and N values of the A horizon of the 30-yr-old Cannelton site are much greater than the other minesoils. Therefore, microbial biomass C and N, potentially mineralizable N, and soil respiration also are greater. However, thickness of the A horizon was similar to other sites, and pH was similar to or a little lower than the other minesoils. I do not know what caused these differences. Additional information on reclamation procedures and/or vegetation establishment might be beneficial, but that information was not provided to us.

The data should not be omitted. They show that minesoils with high levels of carbon will promote microbial activity and vegetation establishment and growth.

5. On page 3, the 1st full paragraph, the 23-year-old site is described as "predominantly forested." The reader can't tell how tall or what dbh the trees are, and what tree species are present. Similarly, elsewhere in the paragraph "trees" and "shrubs" and "legumes" should be replaced by a list of species present.

A more detailed list will be provided.

6. Soil sampling methods are not fully described. How were samples "collected" (second full paragraph) and handled? From what horizon or depth were the samples collected?

At each sampling point, a soil pit was dug to a depth of 40 cm or more to expose enough of the soil to determine the thickness of the surface mineral horizon and to observe one or more subsurface horizons. The soil was described to the exposed depth, and bulk samples were collected with a shovel from the entire thickness of only the described A horizon for laboratory analyses. All samples were placed on ice in coolers and returned to the labortory where they were stored at 4^0 C until they were analyzed.

Results and Discussion

1. Page 5, last paragraph - The statement "The total C values may not be an accurate estimate of organic C in some minesoils because of the presence of coal or high C rock fragments in the sample" needs further elaboration. Is the bias introduced by coal fragments sufficient that it would be better to throw out this data?

As stated in the referenced paragraph, there are inconsistencies in the MBC:TC ratios. However, the MBN:TN ratios appear to fit expected results. Therefore, we were simply trying to present some reason for the inconsistent C ratios. This led to the statement at the end of the paragraph, "Therefore, the N values and ratios are probably more reliable comparisons."

I would not advocate omitting or "throwing out" the carbon data. The coal fragments or high-carbon shales are a natural property of minesoils. It is important to represent the natural variablilty if these soils.

2. In Appendix, Table 2, a number of soil color readings show very low chromas (e.g. N 2.5/0, N3/0, N2/0). Were these in fact coal fragments?

These colors were not of actual fragments, but of the fine-earth material left behind by the weathering of coal fragments and high-carbon shales. The fragments may have had the same color, but we did not give colors of rock fragments in these descriptions.

3. The report concludes with the statement that "the minesoils in this study are approaching stable, developed soils." It is not clear why this is true, given the weak development of soil horizons evident in the minesoils.

Part of this answer was given for item 2 under General Comments. The statement generally relates to the microbial data, especially of the Dal-Tex site, presented in the report. Also, although minesoil horizons show only weak development, they do show improvements over time, and the older minesoils already have some properties that are similar to the native soil.